

Notice of Allowability

Application No.

09/867,251

Examiner

Romain Jeanty

Applicant(s)

YU ET AL.

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 10/16/06.
2. ☒ The allowed claim(s) is/are 1-4,6-11,13-14, and 16.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.


Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
 5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
 - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date 12/22/03
4. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413),
Paper No./Mail Date _____.
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.


Romain Jeanty
Primary Examiner
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Examiner's Amendment

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it **MUST** be submitted no later than the payment of the issue fee.

The claims below represent the pending claims in the application:

Claim 1. An automated system for generating multiple solutions in near real time for n open pairings (where n is an integer) occurring in airline operations, which comprises:

a memory system having stored therein first memory objects defining flight and crew data, legality rules and other data relating to pairings of an airline;

an optimization server in electrical communication with said memory system and receiving user requests for updating said memory system and for generating solutions to cure said n open pairings; and

a microprocessor in electrical communication with said memory system and said optimization server for identifying all deadhead paths occurring among said n open pairings, generating solution components based upon said deadhead paths, storing said deadhead paths and said solution components in said memory system as second memory objects, and upon receiving from said optimization server a user request for curing said n open pairings, extracting said first memory objects and said second memory objects to form an open pairing model, formulating said open pairing model into an integer program data structure to simplify said open pairing model for solution, and generating said multiple solutions based upon said integer

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program data structure to cure said n open pairings, wherein said integer program data structure is provided by an integer program represented by:

$$\sum_{jt} x_{ij}^t = 1 \forall i, \quad (i)$$

$$\sum_{i,j,t} x_{ij}^t(f) + y_f - S_f = 1 \forall f, \text{ and} \quad (ii)$$

$$\text{Objective} = \min. \sum_{i,j} C_{i,j}^t x_{i,j}^t + \sum_f C_f y_f + \sum_f B_f S_f \quad (iii)$$

where "i" represents a first Pairing in a fix, whether broken or unbroken;

where "j" represents a second Pairing in a fix, whether broken or unbroken;

where "f" is an integer indicating a flight identifier;

where " $C_{i,j}^t$ " and " $x_{i,j}^t$ " represent a Cost to an airline in implementing a One-Way Fix " $x_{i,j}^t$ " when

$i \neq j$ and a Self Fix " $x_{i,i}^t$ " when $i = j$;

where " C_f " represents a Cost to an airline for flight f which is not covered by any fixes;

where " y_f " is an integer, where $y_f = 0$ if a flight f is covered by a fix "x" and $y_f = 1$ if flight f is not covered by a fix "x";

where " B_f " represents a Cost of crew over-coverage for flight f;

where " S_f " represents a slack factor referring to a over-coverage of crew to guarantee a feasibility of a solution; and

where "min." represents a minimum function, in which a smallest number in a data set is returned.

Claim 2. The automated system of claim 1, wherein said solution components include partial self-fixes, complete self-fixes, and one-way fixes.

Claim 3. The automated system of claim 1, wherein said multiple solutions include one or

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more n-way swaps.

Claim 4. The automated system of claim 1, wherein one of said solution components is a one-way fix in which an open pairing is cured by taking one or more flights from a single remaining one of said n open pairings.

Claim 5: Cancelled.

Claim 6. The automated system of claim 1, wherein said integer program data structure is comprised of both a crew constraint set and a flight constraint set.

Claim 7. The automated system of claim 1, wherein said solution components are one-way swaps and two-way swaps, and a matching transformation rather than said integer program data structure is used to generate said multiple solutions.

Claim 8. A method of generating in near real time multiple solutions for n open pairings (where n is an integer) in a microprocessor which is in electrical communication with a memory system and an optimization server, which comprises the steps of: receiving memory objects from said memory system which include all crew and flight records, and legality rules defining operations affecting said n open pairings; identifying all deadhead paths occurring among said n open pairings; generating solution components based upon said deadhead paths for reassigning flights among said n open pairings, and storing said solution components in said memory system; upon receiving a request from a user by way of said optimization server to generate solutions to cure an open pairing, extracting one-way swaps and two-way swaps from said solution components to form an open pairing problem; and performing a matching transformation on said open pairing problem based upon said one-way swaps and said two-way swaps to provide said multiple solutions, wherein said integer program data structure is provided by an integer program

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represented by:

$$\sum_{jt} x_{ij}^t = 1 \forall i, \quad (i)$$

$$\sum_{i,j,t} x_{ij}^t(f) + y_f - S_f = 1 \forall f, \text{ and} \quad (ii)$$

$$\text{Objective} = \min. \sum_{i,j} C_{i,j}^t x_{i,j}^t + \sum_f C_f y_f + \sum_f B_f S_f \quad (iii)$$

where "i" represents a first Pairing in a fix, whether broken or unbroken;

where "j" represents a second Pairing in a fix, whether broken or unbroken;

where "f" is an integer indicating a flight identifier;

where " $C_{i,j}^t$ " and " $x_{i,j}^t$ " represent a Cost to an airline in implementing a One-Way Fix " $x_{i,j}^t$ " when

$i \neq j$ and a Self Fix " $x_{i,i}^t$ " when $i = j$;

where " C_f " represents a Cost to an airline for flight f which is not covered by any fixes;

where " y_f " is an integer, where $y_f = 0$ if a flight f is covered by a fix "x" and $y_f = 1$ if flight f is not covered by a fix "x";

where " B_f " represents a Cost of crew over-coverage for flight f;

where " S_f " represents a slack factor referring to a over-coverage of crew to guarantee a feasibility of a solution; and

where "min." represents a minimum function, in which a smallest number in a data set is returned.

Claim 9. The method of claim 8 further including the step of selecting from said multiple solutions a solution of least cost for transmission to said user by way of said optimization server.

Claim 10. The method of claim 8, wherein said matching transformation is comprised of

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the following steps: for each original vertex and mirror vertex comprising a pair representing an open pairing, connecting said original vertex and said mirror vertex with an arc; for any two of said n open pairings, select one of said one-way swaps and said two-way swaps between said any two of said n open pairings having a least cost; joining original vertices of said any two of said n open pairings with a second arc having said least cost; and for each mirror vertex pair, join mirror vertices of said mirror vertex pair with an arc of cost zero.

Claim 11. A method of generating in near real time multiple solutions for n open pairings (where n is an integer) in a microprocessor in electrical communication with a memory system and an optimization server, which comprises: receiving memory objects from said memory system which include crew and flight data, and legality rules relating to said n open pairings; generating solution components for reassigning flights among said n open pairings, and storing said solution components in said memory system; upon receiving a request from a user by way of said optimization server to generate solutions to cure an open pairing, extracting complete self-fixes, partial self-fixes, and one-way fixes from said solution components to form an open pairing problem; applying an integer program to said open pairing problem to formulate said pairing problem into an integer program data structure; and generating said multiple solutions for said n open pairings based upon said integer program data structure, wherein said integer

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program is represented by:

$$\sum_{jt} x_{ij}^t = 1 \forall i, \quad (i)$$

$$\sum_{i,j,t} x_{ij}^t(f) + y_f - S_f = 1 \forall f, \text{ and} \quad (ii)$$

$$\text{Objective} = \min. \sum_{i,j} C_{i,j}^t x_{i,j}^t + \sum_f C_f y_f + \sum_f B_f S_f \quad (iii)$$

where "i" represents a first Pairing in a fix, whether broken or unbroken;

where "j" represents a second Pairing in a fix, whether broken or unbroken;

where "f" is an integer indicating a flight identifier;

where "C_{i,j}^t" and "x_{i,j}^t" represent a Cost to an airline in implementing a One-Way Fix "x_{i,j}^t" when

i ≠ j and a Self Fix "x_{i,i}^t" when i = j;

where "C_f" represents a Cost to an airline for flight f which is not covered by any fixes;

where "y_f" is an integer, where y_f = 0 if a flight f is covered by a fix "x" and y_f = 1 if flight f is not covered by a fix "x";

where "B_f" represents a Cost of crew over-coverage for flight f;

where "S_f" represents a slack factor referring to a over-coverage of crew to guarantee a feasibility of a solution; and

where "min." represents a minimum function, in which a smallest number in a data set is returned.

Claim 12: Cancelled.

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Claims 13. The method of claim 11, wherein said integer program includes a crew constraint set and a flight constraint set.

Claim 14. The method of claim 11, wherein said multiple solutions includes one or more n-way swaps.

Claim 15: Cancelled.

Allowable Subject Matter

2. Claims 1-4, 6-11, 13-14, and 16 are allowed.
3. The following is an examiner's statement of reasons for allowance:

The closest prior art is Sato et al (U.S. Patent No. 6,651,0460. Sato et al discloses an optimizing method for optimization, the total number of crew required for flight services and a crew pairing model calculation unit for calculating a fitness of a solution. However Sato et al fail to teach extracting said first memory objects and said second memory objects to form an open pairing model, formulating said open pairing model into an integer program data structure to simplify said open pairing model for solution, and generating said multiple solutions based upon said integer program data structure to cure said n open pairings, wherein said integer program data structure is provided by an integer program represented by the formula recited in claim 1 above.

The closest prior art is Sato et al (U.S. Patent No. 6,651,0460. Sato et al disclose an optimizing method for optimization, the total number of crew required for flight services and a crew pairing model calculation unit for calculating a fitness of a solution. However Sato et al fails to teach extracting one-way swaps and two-way swaps from said solution components to

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form an open pairing problem; and performing a matching transformation on said open pairing problem based upon said one-way swaps and said two-way swaps to provide said multiple solutions, wherein said integer program data structure is provided by an integer program represented by the formula recited in claim 8 above.

The closest prior art is Sato et al (U.S. Patent No. 6,651,0460. Sato et al disclose an optimizing method for optimization, the total number of crew required for flight services and a crew pairing model calculation unit for calculating a fitness of a solution. However Sato et al fails to teach extracting one-way swaps and two-way swaps from said solution components to form an open pairing problem, performing a matching transformation on said open pairing problem based upon said one-way swaps and said two-way swaps to provide said multiple solutions, wherein said integer program data structure is provided by an integer program represented by the formula recited in claim 11 above.

Claims 2-4, 6-7, 9-10, 13-14, and 16 depend from independent claims 1, 8 and 11; therefore claims 2-4, 6-7, 9-10, 13-14, and 16 are also allowed.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

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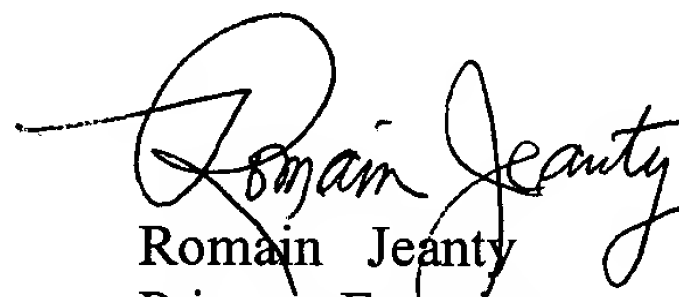
a. Rittri et al (Scheduling Pilot Training) discloses the concept of a scheduling component for activities with complex constraints for pilot training.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Romain Jeanty whose telephone number is (571) 272-6732. The examiner can normally be reached on Mon-Thurs 7:30 a.m. to 6:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tariq R. Hafiz can be reached on (571) 272-6729. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

October 16, 2006


Romain Jeanty
Primary Examiner
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